SECTION 1048

PAVEMENT MARKING MATERIAL

1048.1 Scope. This specification covers preformed pavement marking tape, thermoplastic pavement marking material, preformed removable pavement marking tape and preformed temporary pavement marking tape.

1048.2 Type 1 Preformed Marking Tape.

1048.2.1 Type 1 preformed marking tape shall be capable of being laid into new, dense and open graded asphalt wearing surfaces during the final roller operation. After application the tape shall be immediately ready to receive traffic.

1048.2.2 Composition. The tape shall consist of a mixture of polymeric material, pigments and glass beads distributed throughout the cross-sectional area with a reflective layer of glass beads embedded in the top surface. The tape shall be sufficiently flexible so as to conform to the roadway without cracking or breaking.

1048.2.3 Dimensions. The tape without adhesive shall have a minimum thickness of 60 mils (1.5 mm). A patterned surface is allowable but shall have a minimum thickness of 60 mils (1.5 mm) over at least 50 percent of its surface. The tape shall have a nominal width of 4 inches (100 mm) and the edges shall not be tapered.

1048.2.4 Adhesive. The tape shall be supplied with a pre-coated factory-applied adhesive for immediate application to asphalt pavement without the use of heat, solvent or other adhesive operations. The tape and adhesive shall be of a type that water used on the compaction roller will not be harmful to successful application.

1048.2.5 Reflectance. The tape shall be readily visible when exposed to automobile headlights at night and shall have a minimum specific luminance as shown in the following table, expressed as millicandelas per footcandle (lux) per square foot (square meter). The tape shall be applied to an 8 inch by 36-inch (200 x 900 mm) panel in a longitudinal orientation and measured in accordance with MoDOT Test Method T8 at 86 degrees entrance angle. The reflected color shall be white or yellow as required for the specified application.

Observation Angle	White	Yellow
0.2 degree	550	410
0.5 degree	380	250

1048.2.6 Approval. To obtain approval of Type 1 preformed marking tape, the manufacturer shall submit material and application specifications, samples of the tape, and a history of satisfactory use as a pavement marking tape to the engineer for testing and evaluation. The quantity, types and widths of tape submitted shall be at the discretion of the engineer. Following the testing and evaluation, satisfactory tape will be placed on a prequalified list.

1048.2.6.1 For acceptance on the project, the contractor shall furnish to the engineer a manufacturer's certification in triplicate stating the manufacturer and trade name, and

certifying that the material furnished is of the same composition as originally prequalified and in no way has been altered or changed.

1048.3 Extruded Thermoplastic Marking Material.

1048.3.1 Thermoplastic Compound.

1048.3.1.1 Thermoplastic material shall be in accordance with AASHTO M 249, shall be formulated with alkyd resin, and shall have a maximum specific gravity of 2.35. The pre-mix beads shall be uncoated and shall be in accordance with AASHTO M 247, Type 1.

1048.3.1.2 The thermoplastic material, when melted and ground to the finenesses listed below, shall not have leachable lead or chromium levels greater than 4.0 ppm when tested by the Toxicity Characteristic Leaching Procedure (TCLP, USEPA Method 1311/6010). TCLP leachability testing shall be performed at each of the following levels of fineness:

(a) Coarse Grind - passing 3/8 inch (9.5 mm) and retained on 1/4 inch (6.3 mm) sieve

(b) Medium Grind - passing No. 8 (2.36 mm) and retained on No. 20 (850 µm) sieve

(c) Fine Grind - passing No. 30 (600 µm) sieve

1048.3.2 Primer. Primer, if required, shall be as recommended by the manufacturer of the thermoplastic material.

1048.3.3 Sampling and Testing.

1048.3.3.1 The engineer shall have free access to the material and all facilities for the purpose of inspection. A sample will be taken from each lot of thermoplastic marking material presented for inspection. A lot is defined as 22,000 pounds (10,000 kg), or fraction thereof, presented for inspection at one time regardless of the number of composition batches in the lot. A sample will consist of one 50-pound (23 kg) sample of material packaged in accordance with Sec 1048.3.5. The engineer reserves the right to sample at the point of manufacture, at intermediate points of storage, or at destination.

1048.3.3.2 The thermoplastic material shall be tested in accordance with AASHTO M 249 and AASHTO T 250, as applicable.

1048.3.4 Certification and Acceptance.

1048.3.4.1 The contractor shall furnish a manufacturer's certification in triplicate to the engineer, for each lot furnished, certifying that the material supplied conform to all requirements specified. The certification shall include or have attached typical results of required tests.

1048.3.4.2 Acceptance of the material will be based on the manufacturer's certification and upon the results of such tests as may be performed by the engineer.

1048.3.5 Packaging and Marking.

1048.3.5.1 Thermoplastic material may be furnished as blocks approximately 12 x 37 x 2 inches (300 x 950 x 50 mm) or as granular material in bags. Either unit shall weigh (have a mass of) approximately 50 pounds (23 kg).

1048.3.5.2 Each package shall be labeled or marked with the color of the material, name of the manufacturer, date of manufacture, batch number, type of material (alkyd), net weight (mass) of contents, and the temperature to which the material shall be heated for application. Granular thermoplastic material may be packaged in thermally degradable bags which are designed to melt with the material, provided the label states the bag does not adversely affect the application or performance of the thermoplastic material.

1048.3.6 Drop-On Glass Beads. Drop-on glass beads shall be in accordance with Sec 1048.6.1.

1048.4 Preformed Removable Pavement Marking Tape. Preformed removable tape shall be capable of being removed manually either by hand or with a roll up device and shall leave no objectionable or misleading image after removal.

1048.4.1 Color. The tape shall be white or yellow as required for the specific application.

1048.4.2 Reflectivity. Tape shall be readily visible when exposed to automobile headlights at night and shall have a minimum specific luminance as shown in the following table, expressed as millicandelas per footcandle (lux) per square foot (square meter). The tape shall be applied to an 8 x 36 inch (200 x 900 mm) panel in a longitudinal orientation and measured in accordance with MoDOT Test Method T8 at 86 degrees entrance angle. The reflected color shall be white or yellow as required for the specified application.

Observation Angle	White	Yellow
0.2 degree	1750	1300
0.5 degree	1250	800

1048.4.3 Adhesive. Tape shall have a pre-coated pressure sensitive adhesive that requires no activation procedures. The adhesive shall be resistant to oil, chemicals, acids, solvents and water.

1048.4.4 Dimensions. The tape shall have a minimum thickness of 15 mils (380 µm) and shall have a nominal width of 4 inches (100 mm). Following application, the tape shall remain conformed to the texture of the pavement.

1048.4.5 Durability. The tape shall be weather-resistant and show no appreciable fading, lifting, or shrinkage during its useful life. Samples of the tape applied to standard specimen plates and tested in accordance with Federal Test Method No. 141, Method 6192, for 1000 cycles, using a CS-17 wheel and 1000-gram load shall not expose the backing material.

1048.4.6 Appearance. The tape as applied shall be in good condition, free of cracks and with edges straight and unbroken.

1048.4.7 Approval.

1048.4.7.1 Prior to approval and use of preformed removable tape, the manufacturer shall submit material and application specifications and samples of the tape for testing and evaluation. The quantity, types and widths of tape submitted shall be at the discretion of the engineer. Following the testing and evaluation, satisfactory tape will be placed on a prequalified list.

1048.4.7.2 Preformed removable tape appearing on the prequalified list may be accepted for use on the basis of brand name, color and width as shown in the prequalified list, so long as satisfactory performance is obtained in the field.

1048.5 Preformed Short Term Pavement Marking Tape.

1048.5.1 Color. The tape shall be white or yellow as required for the specific application.

1048.5.2 Reflectivity. The tape shall be readily visible when exposed to automobile headlights at night and shall have a minimum specific luminance as shown in the following table, expressed as millicandelas per footcandle (lux) per square foot (square meter). The tape shall be applied to an 8 x 36 inch (200 x 900 mm) panel in a longitudinal orientation and measured in accordance with MoDOT Test Method T8 at 86 degrees entrance angle. The reflected color shall be white or yellow as required for the specified application.

Observation Angle	White	Yellow
0.2 degree	1350	800
0.5 degree	750	500

1048.5.3 Adhesive. Tape shall have a pre-coated pressure-sensitive adhesive that requires no activation procedures. Adhesive shall be resistant to oil, chemicals, acids, solvents and water.

1048.5.4 Dimensions. Tape shall have a minimum thickness of 15 mils (380 μm) and shall have a nominal width of 4 inches (100 mm). Following application, the tape shall remain conformed to the texture of the pavement.

1048.5.5 Durability. The tape shall be weather resistant and show no appreciable fading, lifting, or shrinkage during its useful life. Samples of the tape applied to standard specimen plates and tested in accordance with Federal Test Method No. 141, Method 6192, for 1000 cycles, using a CS-17 wheel and 1000-gram load shall not expose the backing material.

1048.5.6 Appearance. The tape as applied shall be in good condition, free of cracks and with edges straight and unbroken.

1048.5.7 Approval.

1048.5.7.1 Prior to approval and use of preformed short term marking tape, the manufacturer shall submit material and application specifications and samples of the tape for testing and evaluation. The quantity and type of tape submitted shall be at the discretion of the engineer. In addition, the manufacturer shall submit a certification stating that the material conforms to all of the requirements of these specifications. Following the testing and evaluation, satisfactory tape will be placed on a prequalified list.

1048.5.7.2 Preformed short term marking tape appearing on the prequalified list may be accepted on the basis of brand name and color as shown on the prequalified list, so long as satisfactory performance is obtained in the field.

1048.6 Drop-On Glass Beads.

1048.6.1 Type 1 Drop-On Glass Beads. Type 1 beads shall be moisture resistant and manufactured from glass of a composition that is highly resistant to traffic wear and to the effects of weathering. Glass beads shall be in accordance with AASHTO M 247, Type 1, except as follows.

1048.6.1.1 Roundness. Type 1 beads shall have a minimum of 70 percent true spheres when tested in accordance with ASTM D 1155.

1048.6.1.2 Silica Content. Beads shall be made of glass containing no less than 58.0 percent silica (SiO_2) when tested in accordance with ASTM C 169, Procedures for Referee Analysis.

1048.6.1.3 Water Resistance. The beads shall show no readily discernible dulling and the amount of 0.1 normal hydrochloric acid needed to titrate the filtrate shall not exceed 4.5 mL, when tested in accordance with MoDOT Test Method T70.

1048.6.1.4 Calcium Chloride Resistance. The beads shall show no readily discernible dulling when tested in accordance with MoDOT Test Method T70.

1048.6.1.5 Sodium Sulfide Resistance. The beads shall show no readily discernible darkening or dulling when tested in accordance with MoDOT Test Method T70.

1048.6.2 Type L Drop-On Glass Beads. Type L beads shall be embedment coated and manufactured from glass of a composition that is highly resistant to traffic wear and to the effects of weathering. The beads shall be in accordance with AASHTO M 247, Type 1, except as follows:

1048.6.2.1 Coating. The beads shall be coated to ensure satisfactory embedment and adhesion when applied to uncured traffic marking material. Embedment coating shall be tested in accordance with MoDOT Test Method T70.

1048.6.2.2 Roundness. Type L beads shall have a minimum of 80 percent rounds per screen for the two highest sieve quantities and no more than 3 percent angular particles per screen (determined visually). The remaining sieve fractions shall be determined visually per aspect ratio using microfiche reader to be no less than 75 percent rounds. The tests shall be in accordance with Federal Lands Highway Test Method T520-93.

1048.6.2.3 Gradation. Type L beads shall meet the following gradation requirements when tested in accordance with ASTM D 1214.

Sieve Size	Percent Passing
12 (1.7 mm)	100
14 (1.4 mm)	95 - 100
16 (1.18 mm)	80 - 98
18 (1.00 mm)	10 - 42
20 (850 µm)	0 - 7
25 (710 µm)	0 - 2

1048.6.2.4 Silica Content. Beads shall be made of glass containing no less than 58.0 percent silica (SiO_2) when tested in accordance with ASTM C 169.

1048.6.2.5 Water Resistance. The beads shall show no readily discernible dulling and the amount of 0.1 normal hydrochloric acid needed to titrate the filtrate shall not exceed 4.5 mL, when tested in accordance with MoDOT Test Method T70.

1048.6.2.6 Calcium Chloride Resistance. The beads shall show no readily discernible dulling when tested in accordance with MoDOT Test Method T70.

1048.6.2.7 Sodium Sulfide Resistance. The beads shall show no readily discernible darkening or dulling when tested in accordance with MoDOT Test Method T70.

1048.6.3 Intermix Beads. Intermix beads shall be uncoated and in accordance with AASHTO M 247, Type 1. Intermix beads shall be uniformly mixed throughout the thermoplastic material at the rate of not less than 30 to 35 percent by weight (mass) (retained on the No. 100 (150 µm) sieve) of the thermoplastic material.

1048.6.4 Certification and Acceptance of Glass Beads.

1048.6.4.1 The contractor shall furnish a manufacturer's certification in triplicate for each lot, certifying the beads conform to all requirements specified. The certification shall include or have attached specific results of tests on each lot furnished for roundness, refractive index, flow characteristics, coating type, and gradation. The certifications shall show the quantity and lot number.

1048.6.4.2 Acceptance of the beads will be based on the manufacturer's certification and upon the results of such tests as may be performed by the engineer.

1048.7 Temporary Raised Pavement Markers. The brand name and manufacturer shall be stamped or indelibly printed on each container.

1048.7.1 Type 1 Temporary Raised Pavement Markers. Markers shall consist of an L-shaped or T-shaped flexible polymer body with prismatic reflective tape on the top of both faces of the vertical section. The prismatic reflective faces shall be a minimum of 0.38 square inches (0.002 m^2) for each face. The marker base shall have affixed a pressure-sensitive adhesive, protected by a release paper, for application to the pavement surface. A protective sleeve which prevents contamination of the reflective faces during pavement surface treatment operations shall be affixed to each marker. The protective sleeve shall be easily removable after the work is complete.

1048.7.2 Type 2 Temporary Raised Pavement Markers. Markers shall consist of a plastic shell with prismatic reflective faces with a minimum of 0.38 square inches (0.002 m^2) of reflective surface for each face. If reflective faces are specified on both sides, they shall be 180 degrees opposed. The marker shall be fitted with a pressure-sensitive adhesive for application to a primed surface or may be applied to the pavement surface with a bituminous adhesive material. The markers shall be subject to approval by the engineer.

1048.7.3 Acceptance. Prior to approval and use of temporary raised pavement markers, the manufacturer shall submit to Project Operations samples of the markers and certified results showing that the markers conform to the requirements of this specification. Documentation shall include reflectivity test results for the typical reflector units being furnished. Upon approval of the markers, the brand name will be placed on the list of prequalified temporary raised pavement markers.

1048.8 Hot Spray Thermoplastic Material.

1048.8.1 Thermoplastic Compound

1048.8.1.1 Except where otherwise specified, tests shall be performed in accordance with AASHTO T 250.

1048.8.1.2 The thermoplastic material shall be formulated with alkyd resin and intermix beads for application by the hot spray process at 45 mil (1.15 mm) or 60 mil (1.50 mm) thickness.

1048.8.1.3 The thermoplastic material, when melted, ground to various finenesses, and tested as shown in Sec 1048.3.1.2, shall exhibit leachable lead and chromium levels no greater than 4.0 ppm.

1048.8.1.4 The binder shall consist of a mixture of synthetic alkyd resins, at least one of which is solid at room temperature. The total binder content of the thermoplastic compound shall be well distributed through the compound. The binder shall be free from all foreign

objects or ingredients that would cause bleeding, staining or discoloration. The binder shall be 25 percent minimum by weight (mass) of the thermoplastic compound.

1048.8.1.5 Pigment.

1048.8.1.5.1 White. The pigment used for the white thermoplastic compound shall be a minimum 93 percent, pure titanium dioxide. The white pigment content shall be no less than 10 percent by weight and shall be uniformly distributed throughout the thermoplastic compound.

1048.8.1.5.2 Yellow. The pigments for the yellow thermoplastic compound shall be nontoxic, heat resistant, and color-fast yellows, golds and oranges, which shall produce a compound meeting the requirements of Federal 595 Color No. 33538.

1048.8.1.5.3 Filler. The filler shall be a white, calcium carbonate, silica, or an approved substitute. Any filler which is insoluble in 6 N hydrochloric acid shall be of such particle size as to pass a No. 100 (150 µm) sieve.

1048.8.1.6 Mixed Compound.

1048.8.1.6.1 Reflectance and Color. The mixed thermoplastic compound, after heating 2.2 pounds (1000 g) in an open, friction-top can for 4 hours ± 5 minutes at 375 ± 3 F (190.6 ± 2 C) and cooling at 77 F (25 C), shall meet the following requirements for daylight reflectance and color, when tested using a color spectrophotometer with 45 degree circumferential/0 degree geometry, illuminant C, and 2 degree observer angle. The color instrument shall measure the visible spectrum from 380 to 721 nm with a wavelength measurement interval and spectral bandpass of 10 nm.

Color	Daylight Reflectance (Y)
White	75 percent min
Yellow[a]	42 to 59 percent

[a]Shall match Federal 595 Color No. 33538 and chromaticity limits as follows:

x	0.470	0.510	0.485	0.530
y	0.455	0.485	0.425	0.456

1048.8.6.2 Specific Gravity. The specific gravity of the thermoplastic material shall not exceed 2.15.

1048.8.6.3 Softening Point. After heating the thermoplastic as described in Sec 1048.8.1.5.1 and testing in accordance with ASTM E 28, the material shall have a minimum softening point of 180 F (82.2 C) as measured by the ring and ball method.

1048.8.6.4 Tensile Bond Strength. After heating the thermoplastic as described in Sec 1048.8.1.5.1, the tensile bond strength to unprimed, sandblasted Portland cement concrete block, 0.0625 inch (1.587 mm) thick film drawdown at 375 F (190.6 C), test at 75 ± 2 F (23.0 ± 1 C) shall exceed 180 psi (1.24 MPa) when tested in accordance with ASTM D 4796.

1048.8.6.5 Impact Resistance. After heating the thermoplastic as described in Sec 1048.8.1.5.1, the impact resistance shall be a minimum of 50 inch-pounds (5.65 N-m) with no cracks or bond loss when 0.0625 inch (1.587 mm) thick film drawdown is made at 375 F (190.6 C) on an unprimed, sandblasted Portland cement concrete block, male indentor 5/8 inch (15.875 mm), no female die, tested at 75 ± 2 F (23.9 ± 1 C) when tested in accordance with ASTM D 2794.

1048.8.6.6 Yellowness Index. The white thermoplastic material shall not exceed a yellowness index of 0.12 when tested in accordance with AASHTO T 250.

1048.8.7 Packaging.

1048.8.7.1 The thermoplastic material shall be packaged in suitable containers that will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 pounds (22 kg). Each container shall designate the color, type of binder, spray and user information. The label shall warn the user the material shall be heated in the range of 350 to 425 F (177 to 218 C).

1048.8.7.2 Each package shall be marked with the name of the manufacturer, type of material, month and year the material was packaged, and lot number. The letters and numbers shall be a minimum of 1/2 inch (12 mm) high.